

METHODS AND SYSTEMS FOR NEURAL STIMULATION VIA VISUAL, AUDITORY AND PERIPHERAL NERVE STIMULATIONS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of priority under 35 U.S.C. § 120 as a continuation of U.S. patent application Ser. No. 15/816,238, filed Nov. 17, 2017, and issuing as U.S. Pat. No. 10,307,611 on Jun. 4, 2019, which claims the benefit of and priority to U.S. Provisional Application No. 62/423,452, titled “METHODS AND SYSTEMS FOR NEURAL STIMULATION VIA VISUAL STIMULATION,” filed Nov. 17, 2016, U.S. Provisional Application No. 62/431,698, titled “METHODS AND SYSTEMS FOR NEURAL STIMULATION VIA VISUAL STIMULATION,” filed Dec. 8, 2016, U.S. Provisional Application No. 62/423,569, titled “METHODS AND SYSTEMS FOR NEURAL STIMULATION VIA AUDITORY STIMULATION,” filed Nov. 17, 2016, U.S. Provisional Application No. 62/431,702, titled “METHODS AND SYSTEMS FOR NEURAL STIMULATION VIA AUDITORY STIMULATION,” filed Dec. 8, 2016, U.S. Provisional Application No. 62/423,517, titled “METHODS AND SYSTEMS FOR NEURAL STIMULATION VIA PERIPHERAL NERVE STIMULATION,” filed Nov. 17, 2016, U.S. Provisional Application No. 62/431,720, titled “METHODS AND SYSTEMS FOR NEURAL STIMULATION VIA PERIPHERAL NERVE STIMULATION,” filed Dec. 8, 2016, U.S. Provisional Application No. 62/423,598, titled “METHODS AND SYSTEMS FOR NEURAL STIMULATION VIA VISUAL AND AUDITORY STIMULATIONS,” filed Nov. 17, 2016, U.S. Provisional Application No. 62/431,725, titled “METHODS AND SYSTEMS FOR NEURAL STIMULATION VIA VISUAL AND AUDITORY STIMULATIONS,” filed Dec. 8, 2016, U.S. Provisional Application No. 62/423,557, titled “METHODS AND SYSTEMS OF SENSING FOR NEURAL STIMULATION,” filed Nov. 17, 2016, U.S. Provisional Application No. 62/423,536, titled “SYSTEMS AND METHODS FOR PROVIDING ASSESSMENTS FOR NEURAL STIMULATION,” filed Nov. 17, 2016, and U.S. Provisional Application No. 62/423,532, titled “METHODS AND SYSTEMS OF DOSING FOR NEURAL STIMULATION,” filed Nov. 17, 2016, the entire disclosures of which are incorporated herein in their entireties for any and all purposes.

FIELD OF THE DISCLOSURE

[0002] This disclosure relates generally to methods and systems for neural stimulation. In particular, the methods and system of the present disclosure can provide stimulation signals, including visual, auditory and peripheral nerve stimulation signals, to induce synchronized neural oscillations in the brain of a subject.

BACKGROUND

[0003] Neural oscillation occurs in humans or animals and includes rhythmic or repetitive neural activity in the central nervous system. Neural tissue can generate oscillatory activity by mechanisms within individual neurons or by interactions between neurons. Oscillations can appear as either oscillations in membrane potential or as rhythmic patterns of action potentials, which can produce oscillatory activation

of post-synaptic neurons. Synchronized activity of a group of neurons can give rise to macroscopic oscillations, which can be observed by electroencephalography (“EEG”). Neural oscillations can be characterized by their frequency, amplitude and phase. Neural oscillations can give rise to electrical impulses that form a brainwave. These signal properties can be observed from neural recordings using time-frequency analysis.

BRIEF SUMMARY OF THE DISCLOSURE

[0004] Systems and methods of the present disclosure are directed to neural stimulation via visual stimulation. Visual stimulation, including visual signals, can affect frequencies of neural oscillations. The visual stimulation can elicit brainwave effects or stimulation via modulated visual input. The visual stimulation can adjust, control or otherwise manage the frequency of the neural oscillations to provide beneficial effects to one or more cognitive states or cognitive functions of the brain or the immune system, while mitigating or preventing adverse consequences on a cognitive state or cognitive function. For example, systems and methods of the present technology can treat, prevent, protect against or otherwise affect Alzheimer’s Disease.

[0005] External signals, such as light pulses, can be observed or perceived by the brain. The brain can observe or perceive the light pulses via the process of transduction in which specialized light sensing cells receive the light pulse and conduct electrons or information to the brain via optical nerves. The brain, in response to observing or perceiving the light pulses, can adjust, manage, or control the frequency of neural oscillations. This stimulation can result in repeated activation of portions of the brain which are known to process input, such as the visual cortex. For example, light pulses generated at predetermined frequency and perceived by ocular means via a direct visual field or a peripheral visual field can trigger neural activity in the brain to cause a predetermined or resulting frequency of neural oscillations. The frequency of neural oscillations can be affected by or correspond to the frequency of light pulses. Thus, systems and methods of the present disclosure can provide brainwave entrainment (or neural entrainment) using external visual stimulus such as light pulses emitted at a predetermined frequency to synchronize electrical activity among groups of neurons based on the frequency of light pulses. Brain entrainment (or neural entrainment) can be observed based on the aggregate frequency of oscillations produced by the synchronous electrical activity in ensembles of cortical neurons.

[0006] At least one aspect is directed to a system for neural stimulation via visual stimulation. The system can include or refer to a neural stimulation system or a visual neural stimulation system. The neural stimulation system can include, interface with, or otherwise communicate with a light generation module, light adjustment module, unwanted frequency filtering module, profile manager, side effects management module, or feedback monitor. The neural stimulation system can include, interface with, or otherwise communicate with a visual signaling component, filtering component, or feedback component.

[0007] At least one aspect is directed to a method of neural stimulation via visual stimulation. The method can include a neural stimulation system identifying a visual signal to provide. The neural stimulation system can generate and transmit the identified visual signal. The neural stimulation